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Before the
Federal Communications Commission
Washington, D.C. 20554

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FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554

In the Matter of)
)
Amendment of the Commission's Rules)
to Establish Part 27, the Wireless) GN Docket No. 96-228
Communications Service ("WCS"))

To: The Commission

Opposition to Petition for Expedited Reconsideration

Primosphere Limited Partnership ("Primosphere"), by its attorneys, hereby respectfully submits this Opposition to the Petition for Expedited Reconsideration filed by the PACS Providers Forum in the above-captioned proceeding on March 11, 1997. Primosphere is an applicant for authority to construct, launch and operate a Satellite Digital Audio Radio Service (SDARS) system in the 2310-2360 MHz band.¹ As such, Primosphere has a vital interest in this proceeding which addresses allocation and licensing of communications services in the 2310-2360 MHz band.

I. Introduction

In the Report and Order establishing service and technical rules for the Wireless Communications Service (WCS), the Commission adopted out-of-band

¹ See Primosphere Application, File Nos. 29/30-DSS-LA-93 and 16/17-DSS-P-93, filed on December 15, 1992.

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emissions limits for WCS that were needed to protect SDARS, which operates in the bands adjacent to the WCS spectrum (2320 - 2345 MHz). Specifically, the Commission adopted a limit of $80 + 10 \log (P)$ dB for fixed operations and $110 + 10 \log (P)$ dB for mobile operations.²

On March 13, 1997, the PACS Providers Forum (PPF) and Digivox Corporation filed a Petition for Expedited Reconsideration of the Commission's Report and Order. In the Petition, PPF and Digivox claim that the Commission adopted overly restrictive out-of-band emissions limits and had not considered all the material on the record.

The Petition filed by PPF and Digivox is nothing more than an attempt to reintroduce material that has already been carefully considered by the Commission. The Petition offers no new information to the Commission and raises no new issues that were not directly addressed by the Commission in its WCS Report and Order. The Commission should therefore deny the Petition for Expedited Reconsideration and proceed to auction of the WCS spectrum with the emission limits adopted in the Report and Order.

II. The Existing Limits Adopted in the Report and Order are Necessary and Based on the Record.

In adopting limits on out-of-band emissions for transmitters in the WCS, the Commission noted its concern about accommodating the different types of services that will operate in the 2310 - 2360 MHz band:

² Report and Order, GN Docket 96-228 (released February 19, 1997) at ¶ 136.

While it is our desire to provide WCS licensees with the maximum flexibility to provide a wide range of services, we also must ensure that WCS operations do not cause harmful interference or disruption to adjacent satellite DARS reception or the operations of the Arecibo Observatory.³

The Commission carefully considered submissions of all interested parties in arriving at the emissions limits adopted in the Report and Order. Seven different entities filed comments in the WCS proceeding requesting that more stringent emissions limits be adopted, including all four SDARS applicants.⁴ The Commission addressed the concerns of these applicants, as well as those expressed by Digivox. Despite this robust record, the PPF/Digivox Petition addresses only the material presented by Primosphere concerning the out-of-band emissions issue. Thus, PPF/Digivox has not explained how the Commission's decision is at odds with the record as a whole. No where does PPF/Digivox provide a basis for revisiting the Commission's decision.

Lacking a substantive basis for attacking the out-of-band emission limits adopted in the WCS Report and Order, PPF and Digivox allege that the Commission failed to take into account certain *ex parte* filings made on behalf of Digivox. These filings, however, were thoroughly refuted by Primosphere in its *ex parte* response to the PPF/Digivox *ex parte* filings. PPF/Digivox apparently conclude that their *ex parte* filings were ignored simply because the limits suggested in those filings were not adopted. The Commission did not ignore the PPF/Digivox *ex parte* filings. Rather, the Commission determined that, based on

³ Id.

⁴ Id. at ¶¶ 126 - 135.

the record, including Primosphere's rebuttal of the PPF/Digivox *ex parte* filing, the adopted out-of-band emission limits were required to protect adjacent band services.

III. The Technical Information Submitted by PPF/Digivox Provides No Basis for Reversing the Commission's Decision on Out-of-Band Emission Limits.

1. The PPF/Digivox Statements regarding duty cycles for WCS transmitters apply only to WCS systems employing pulsed transmissions

The technical material submitted by PPF and Digivox in their Petition for Reconsideration is based on a single system standard. PPF/Digivox rely heavily on their assertion that duty cycle limitations for WCS transmitters will provide protection to SDARS. Contrary to the claims of PPF/Digivox, the duty cycles identified by PPF/Digivox would *still* cause harmful interference to the SDARS signal.⁵ In addition, because the proposed rules contain no restriction on the type of modulation used by WCS licensees, such protection would only be possible with systems using similar pulsed transmissions. The duty cycle protection claimed by PPF/Digivox is system specific and provides no assurance to SDARS licensees since there is no guarantee that all the winners of the WCS auctions will employ similar duty cycles, or any pulsed transmission scheme at all. Even if the PPF/Digivox claims regarding the alleged protection afforded by duty cycles was true, unless this very specific transmission scheme is adopted by all WCS

⁵ Technical Statement at pp 6-7.

licensees, any protection will be illusory.

2. The PPF/Digivox Technical Material Contains Erroneous Information.

The Technical Exhibit attached to this Opposition details the numerous substantive flaws in the PPF/Digivox analysis. These are discussed below.

a. PPF/Digivox fail to calculate properly the potential interference from multiple WCS service providers operating in the WCS bands.

PPF/Digivox claim that WCS transmissions will not cause unacceptable interference to SDARS receivers. This claim is based on the assumption of a 2 dB increase in the noise floor from out-of-band emissions interference from a single WCS transmitter. PPF/Digivox claim that a WCS transmitter would not interfere with a SDARS receiver unless it is within 12 feet of the SDARS receiver. This 12-foot zone, however, is calculated using grossly inaccurate information about the sensitivity of the SDARS receiver to WCS interference. When these false assumptions are corrected, the actual range within which a WCS transmitter will cause interference to a WCS receiver is 850 feet.⁶ Within this range, it is likely that multiple WCS transmitters will be operating, making the PPF/Digivox assumptions wholly inappropriate.

b. PPF/Digivox fail to recognize that specific roll-off recommendations are necessary for guard bands to be effective.

A guard band will not protect SDARS receivers unless the roll-off requirements for the band guarantee that the emissions into the SDARS band are below harmful levels. Any reference to guard bands as a means of protection is

⁶ Technical Statement at 8.

senseless unless roll off requirements and specific emission limits are adopted.⁷

- c. PPF/Digivox make incorrect assumptions about the margin available in the SDARS noise floor and the potential interference WCS will cause to SDARS.

As the chart on page 3 of the Technical Statement explains, the PPF/Digivox analysis of the SDARS receiver's sensitivity to interference contains numerous fallacious assumptions. These assumptions falsely minimize the impact WCS will have on SDARS and grossly overstate the SDARS receiver's resistance to WCS interference.

- d. The PPF/Digivox analysis of potential path blockage of the SDARS signal is incorrect.

Digivox claims that PACS out of band emissions will be insignificant in comparison to path blockage for SDARS. This statement is based on a disputed study of terrestrial DARS transmissions that predicts outages from path blockage of between 45% and 90%.⁸ In contrast, Primosphere has identified several extensive, long-term studies of SDARS that show expected outages will occur only about 2% of the time.⁹ The effects of the WCS out-of-band emissions proposed by PPF/Digivox would be substantially greater than the impact of path blockage.

The errors identified in the Technical Statement greatly distort the conclusions reached by Digivox. When these errors are corrected, the Digivox analysis actually confirms that the out-of-band emissions limits adopted by the

⁷ Technical Statement at 4-5.

⁸ Id. at 11.

⁹ Id. at 12.


Commission are proper.¹⁰ Consequently, the Commission correctly considered both the PPF/Digivox and Primosphere *ex parte* filings, along with the entire record of the WCS proceeding, in reaching its decision on the out-of-band emission limits.

PPF/Digivox also allege that Primosphere has withheld information from them. As the attached Statement of Richard S. Cooperman shows, no such information has been withheld. In fact, Primosphere has made numerous efforts to accommodate the requests of Digivox and to facilitate its access to relevant information.

III. Conclusion

For the foregoing reasons, the Commission should dismiss the Petition for Expedited Reconsideration filed by PPF and Digivox and affirm the out-of-band emission limits adopted in the WCS Report and Order.

Respectfully submitted,



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Dated: March 21, 1997

¹⁰ Technical Statement at Table 1.

TECHNICAL STATEMENT OF PRIMOSPHERE LP
IN SUPPORT OF RESPONSE
TO
PETITION FOR EXPEDITED RECONSIDERATION
GN DOCKET No. 96-228

1. INTRODUCTION

On March 11, 1997 DigiVox Corporation ("DigiVox") and the PACS Provider Forum ("PACS Forum") jointly filed a Petition for Reconsideration of out-of-band emission standards set by the Commission in its rule making for the Wireless Communications Service ("WCS") Docket GN 96-228. Contained in this filing are technical assertions in support of the petition and other technical material from interested equipment suppliers. The filing also refers to an ex parte letter filed with the Commission by DigiVox on February 5, 1997. The technical statements in the Petition for Reconsideration, its attached letters and the ex parte filing of February 5, 1997 are severely flawed and contain numerous glaring errors. Further, the technical issues discussed in these documents were all previously raised with the Commission and clearly refuted prior to the issuance of the WCS Rule Making. Thus the Commission should ignore the recommendations of the DigiVox and the PACS Providers Forum and reject the Petition for Reconsideration.

The Petition for Reconsideration contains material addressing four basic issues:

1. SDARS requirements for protection from WCS operations out-of-band emissions;
2. The establishment of 5 MHz buffer zones on either side of the SDARS band to protect SDARS;
3. An estimate of WCS out-of-band emissions into the SDARS band; and
4. A statistically based estimate of the distance between DigiVox transmitters and SDARS receivers.

Primosphere has carefully reviewed the technical statement made in support of reconsideration and presents the following material in response.

2. SDARS PROTECTION REQUIREMENTS

The Satellite Digital Audio Radio Service (SDARS) is a satellite based service for mobile vehicles in the United States. As with all satellite based systems, the space-to-earth link is the most critical point in the system. The Primosphere space-to-earth link¹ is designed to have a margin of 10% in clear line-of-sight to a fixed SDARS receiver without interference from man-made sources. This margin is put into the system at great expense to ensure that the SDARS service is robust and tolerant of the propagation anomalies found in the mobile environment. The Primosphere service must contend with multi-path fading, atmospheric fading, blockages and interference from man-made sources. In its link design Primosphere has utilized state-of-the-art signal processing technology to enhance reception of its signal in the face of the real world mobile environment.

Primosphere has allowed for a 5%, or approximately 0.2 dB, increase in its receiver noise for out-of-band emission interference from a single transmitter operating in the WCS bands. This is a reasonable allocation since in one geographic area there will be multiple WCS service providers offering different services. Thus, SDARS must contend with out-of-band emissions from multiple service providers and will simultaneously see out-of-band emissions from multiple WCS transmitters. Since the interference from multiple WCS transmitters is additive the actual amount of out-of-band emission noise seen by one SDARS receiver will be significantly higher than 0.2 dB. Thus, an allocation of 0.2 dB for each interfering WCS transmitter is quite reasonable, more reasonable than the allocation of 2 dB for each interferer, as proposed by DigiVox.

Primosphere has performed extensive analysis in establishing its receiver noise floor of 200° K. HNS dismisses this value with a series of generalized claims that do not reflect the planned Primosphere receiver design. These erroneous assumptions are addressed on the following table:

¹ Application of Primosphere Limited Partnership, GEN Docket 90-357, December 15, 1992, Appendix 1, page 6.

	<u>Primosphere Design</u>	<u>HNS claim</u>	<u>Comment</u>
LNA noise figure	0.7 dB	1.0 dB	Commercially available amplifiers
Post LNA contribution	0.2 dB	1.0 dB	The HNS claim that post LNA effects would degrade the NF by 1 dB is without justification. Common sense receiver design utilizing low cost commercially available components will isolate the receiver front end from the impact of the downstream mixer and filter.
Filter insertion loss	0.0 dB	2.0 dB	Primosphere does not plan to place a lossy filter in front of the LNA as HNS assumes. The LNA will be able to operate linearly with a 1-2 watt WCS signal as long as the distance is at least 10 feet from the SDARS receiver. After the LNA stage, filtering will be provided to avoid signal suppression and intermodulation effects in the back end of the receiver. By placing the first stage of amplification prior to the filter the impact of the filter's insertion loss is eliminated.
Environment temperature	125 deg-K	290 deg-K	Experimental testing performed with an antenna mounted on an automobile has shown that antenna temperature range from 100° to 150° K under typical operating condition at S-Band frequencies. Note that higher temperatures occur when the antenna is under an overpass or tree canopy. Primosphere utilizes other techniques to combat these conditions.
Microwave ovens	negligible effect	worry	As discussed by Vogel in a previous Primosphere filing ²

Combining the quantities shown above gives a receiver noise density of -145.6 dBW/MHz. Since Primosphere's system specifications are based on this number, Primosphere prefers to utilize this quantity than the "split the difference" approach proposed by HNS.

² Vogel, "Estimate of Interference from Microwave Ovens into Satellite Digital Audio Radio Service ('SDARS') Bands", January 20, 1997.

In addition SDARS receivers will see out-of-band emission interference from sources other than WCS. In fact the DigiVox letter itself enumerates many of these sources of interference. In its link design Primosphere has allocated link margin to contend with interference from a broad array of sources including WCS transmitters. However, allowing a 2 dB increase in receiver noise floor from just a single WCS transmitter, as recommended by DigiVox is unreasonable. At this level a small number of WCS transmitters would wipe out SDARS reception in a large area.

The DigiVox assertion that PACS interference should be allowed to increase the SDARS receiver noise floor by 2 dB from a single source demonstrates their lack of knowledge of satellite communications links. In order to maintain the needed quality of service with an increase of 2 dB in the receiver noise floor, the satellite transmitted power would need to be raised by a like amount. The satellite's solar array would then have to be increased by approximately 4,000 watts to over 10,000 watts which would drastically increase the satellite weight and cost. Allowing a degradation of 0.2 dB due to PACS emissions can be accommodated by a more modest increase in satellite power.

The WCS out-of-band emission requirements as established by the Commission in its Rule Making are reasonable, necessary to protect SDARS from interference, and can be implemented in an economic manner. Improved transmitter out-of-band filtering coupled with spectrum shaping and cross polarization can be used to meet the out-of-band emission requirements proposed by Primosphere. DigiVox and other potential PACS service providers should not be allowed to pollute the SDARS band, a band literally sandwiched between the WCS band segments.

3. GUARD BANDS

DigiVox cites establishment of 5 MHz guard bands on either side of the SDARS band as protection for SDARS. DigiVox goes on to state that "the 5 MHz buffer zone would protect SDARS from most out of band emissions that would result from using PACS in the two paired bands." DigiVox does not describe how this segmentation and restriction in the use of the WCS bands will protect SDARS from interference generated by WCS.

DigiVox fails to recognize that the out-of-band emissions interference limits it recommends do not include a recommendation as to roll-off with frequency. Without such a recommendation guard bands are meaningless and provide no protection to other services. The only meaningful parameter for

protecting SDARS is the level of out-of-band emissions appearing in the SDARS band. The guard band only helps the PACS equipment manufacturer meet the out-of-band emission requirements.

4. ESTIMATE OF PACS INTERFERENCE INTO THE SDARS BAND

DigiVox attempts to justify its loose out-of-band emission limit recommendations on link calculations by yet again referring to material contained in Tables 1 and 2 of a letter from HNS dated January 28, 1997. This letter was previously submitted to the Commission in several ex parte filings^{3,4} by DigiVox and its findings were clearly refuted in an ex parte letter filed by Primosphere⁵. The link calculations in these two tables contain several falsely optimistic assumptions and seriously underestimate the level of out-of-band emissions into the SDARS band. DigiVox persists in repeatedly submitting these inaccurate tables to the Commission. In the hope of bringing the contents of these tables in line with fact, Primosphere presents the following detailed analysis:

4.1 REVERSE DIRECTION INTERFERENCE LINK BUDGET - TABLE 1

This table analyzes the mobile to base station link. Primosphere has included Table 1 from the previously referenced letter as an attachment to this Technical Exhibit and has added the following information:

1. A column showing the reverse link interference calculation using the out-of-band emissions limits set forth in the WCS Rulemaking;
2. A column showing a reverse link calculation based on the limit proposed by DigiVox and correcting the engineering errors; and,
3. A column of revised comments.

³ Ex Parte letter to the Commission on behalf of DigiVox, from Eliot Greenwald, Counsel to DigiVox, January 28, 1997.

⁴ Ex Parte letter to the Commission on behalf of DigiVox, from John Prawat, DigiVox CEO, February 5, 1997.

⁵ Ex Parte letter to the Commission on behalf of Primosphere, from Robert Ungar, Counsel to Primosphere, January 30, 1997.

As noted by Primosphere in its ex parte filing of January 30, 1997, Table 1 contains several erroneous assumptions as to signal isolation that result in a significant under estimate of PACS out-of-band emissions interference into the SDARS band. The following is a description of the erroneous assumptions outlined in Table 1.

4.1.1 9 dB of isolation based on a 12.5% duty cycle burst mode operation.

DigiVox Assumption:	9 dB of isolation
Actual:	0 dB of isolation

DigiVox and HNS erroneously state many times that since the PACS system is pulsed, average not peak power is the parameter of importance. Primosphere would agree with this conclusion if the pulse width of the PACS interference was shorter than the SDARS symbol duration. However, the SDARS system will operate at a data rate on the order of 8 Mbps. The symbol duration will be 0.125 microsecond which is much shorter than the PACS burst of 312 microsecond. Thus, every time a PACS burst is emitted, a 312 microsecond segment of SDARS data will be corrupted. Demonstrating the fallacy of DigiVox's argument, if the PACS peak (hence average) power was increased by 20-30 dB, in the real world, there would be no change in the number of bits that were affected since they had already been destroyed at the lower power level. Increasing the average power level would not affect performance hence the quantity "average power" is not of importance; the metric of interest is the number of bits corrupted during the period that the pulse is at its peak level. Since the PACS duty cycle is 12.5%, one out of eight SDARS bits or 2,496 bits every 2.5 ms, would be affected by the PACS interference. This will be heard by every SDARS user as a very annoying interruption at a 400 Hz rate. This is clearly an unacceptable outcome.

It is interesting to note that DigiVox persists in asserting that average power is the quantity that should be taken into consideration even though it was advised by Primosphere on January 30, 1997⁶ that average power was not appropriate. In the DigiVox filing for reconsideration HNS states⁷ that:

"The next point is the Primosphere assertion that a '312 microsecond long burst ever 2.5 milliseconds will break a communication link just as well as

⁶ Ibid.

⁷ Letter dated February 5, 1997 from Stan Key , Assistant VP HNS to John Prawat President and CEO DigiVox.

a continuous signal' may or may not be correct. If for example, the symbol time is 2.5 milliseconds, then HNS' claim that the 312 microsecond interference will be averaged over the symbol is correct."

This is simply not correct. A symbol time of 2.5 milliseconds corresponds to a data rate of 400 bps which clearly is not compatible with SDARS. Thus HNS and DigiVox should have realized that the averaging claim was not appropriate but nonetheless proceeded with the assertion in their filings with the Commission.

In addition, DigiVox's assertions regarding duty cycle would apply only to systems using the same duty cycle as DigiVox. Clearly another system provider may not be using a TDMA-type approach and might not have *any* duty cycle at all. This would make the interference situation even worse since the out-of-band emission limitation formula is not reflective of any type of transmission mode.

4.1.2 5 dB of isolation for energy absorbed by human head.

DigiVox Assumption:	5 dB of isolation
Actual:	1-2 dB of gain

A handset transmission is only partially shielded by the head of the operator. At best, the operator's head physically blocks the signal for about 60° of the 360° circumference around the handset antenna. Thus, there is no "human head" isolation for all but a small segment of viewing angle.

In computing the PACS out-of-band emissions power falling into the SDARS band, HNS assumes a 6 dB "head loss" and states that "3 to 15 dB is typical for energy absorbed by the human head".⁸ This assertion is without reference to any experimental results. Recent testing has demonstrated that the human head not only absorbs energy at these frequencies but also acts as a reflector^{9,10}. The antenna pattern in the direction through the head is reduced by 2 to 5 dB, but away from the head it is increased by 1 to 2 dB. Thus "head effects" cause PACS out-of-band emissions interference to become more severe for SDARS dependent upon the relative user's orientation and must be considered in the link budget.

⁸ Ibid

⁹ Jensen and Rahmat-Samil, "EM Interaction of Handset Antennas and a Human in Personal Communications", Proceedings of the IEEE, January 1995, pp. 7-17

¹⁰ Experiments performed by Primosphere.

4.1.3 6 dB of isolation for being off SDARS antenna main beam.

DigiVox Assumption:	6 dB of isolation
Actual:	0 dB of isolation

Simple geometry shows that a PACS user standing on a sidewalk holding a hand held PACS transmitter would be well within the main beam of a vertical trunk mounted SDARS whip antenna. In addition, Primosphere's antenna is designed to cover a wide range of elevation angles in support of users throughout CONUS who may happen to be on a tilted terrain. Consequently, Primosphere expects very little isolation to a WCS user with the likely orientations. Thus there is no isolation to be gained from being off the antenna main beam.

4.1.4 3 dB of Isolation For Polarization Loss

DigiVox Assumption:	3 dB of isolation
Actual:	1-2 dB of isolation

DigiVox assumes 3 dB of isolation based on the fact that the PACS signal is linearly polarized and the SDARS antenna is circularly polarized. While this is theoretically possible, attainable antenna isolation is actually 1-2 dB when one considers actual axial ratios, particularly at low elevation angles. Primosphere has used 2 dB in its analysis. It is curious that a mobile, hand held system like PACS, is not designed with a circular antenna polarization. Circular antenna polarization would provide better performance, and if designed to be cross-polarized with SDARS could achieve 10-15 dB of isolation between PACS and SDARS without performance penalty.

Thus, taking the above corrections into account, the DigiVox filing underestimates interference from a PACS handset into the SDARS band by 23 - 26 dB.

DigiVox then goes on to calculate margin based on its flawed assumption that a 2 dB increase in SDARS noise floor from a single handset is acceptable. The result is a wildly optimistic estimate of SDARS resistance to out-of-band emissions interference coming from PACS units operating in the WCS bands. The result is a DigiVox calculation of 7.9 dB of margin and a corrected calculation of a 29.1 dB deficit. That is a dramatic 37 dB difference!

Clearly, the assertion by DigiVox that reduced out-of-band emission limits are safe is totally wrong and should be rejected. Primosphere calculates that a PACS hand held unit would have to be over 850 feet away from an SDARS

receiver to have the margin calculated by DigiVox. This calculation is based on the corrections listed above and a 0.2 dB increase in SDARS receiver noise from a single PACS hand held unit.

4.2 FORWARD DIRECTION INTERFERENCE LINK BUDGET - TABLE 2

This table analyzes the base station to mobile link. Primosphere has included Table 2 from the previously reference letter, adding the following information:

1. A column showing the reverse link interference calculation using the out-of-band emissions limits set forth in the WCS Rule making;
2. A column showing a reverse link calculation based on the limit proposed by DigiVox and correcting the engineering errors; and,
3. A column of revised comments.

4.2.1 PACS Base Station Antenna Gain and Path Loss

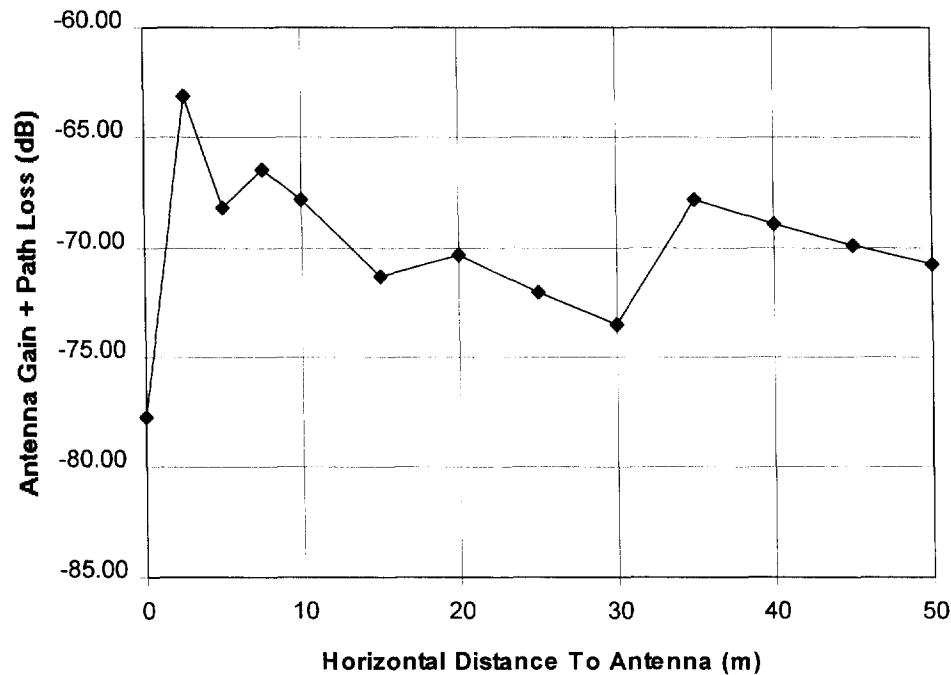
DigiVox Assumption:	-20.0 dB Directivity Loss -57.8 dB Path Loss
Actual:	-11.0 dB Directivity Loss -58.2 dB Path Loss

In support of use of -20 dB isolation between the PACS base station antenna and the SDARS antenna ¹¹ HNS uses as an example the mounting of the base station antenna on cables holding traffic signals. HNS goes on to assert that the maximum interference case is when the SDARS equipped vehicle is directly under the antenna. While this may be the closest the SDARS antenna gets to the PACS antenna, it is not the point of maximum interference. As an SDARS equipped vehicle approaches an intersection with a PACS antenna the path loss decreases. At the same time PACS antenna gain decreases since the SDARS receiver moves off boresight. Using the manufacturers measured antenna pattern Primosphere has graphed the PACS Antenna Gain + Path Loss vs Horizontal Distance to a PACS antenna mounted 8 m above an intersection. This graph is provided in Figure 1. The side lobes of the PACS antenna coupled with the path loss show worst case interference occurs not directly under the PACS antenna, but rather shortly before and after passing under the PACS

¹¹ Letter dated January 27, 1997 from Stan Key, assistant VP HNS, to John Prawat President and CEO DigiVox.

antenna. At this point the isolation is on the order of -12 dB not -20 dB. Further anything mounted on traffic signal support cables will be significantly affected by wind. This movement will likely change the point of maximum interference and reduce the isolation further.

Figure 1



There are also inconsistencies in the stated PACS base station antenna characteristics. The antenna in Table 2 of the January 30, 1997 letter from HNS is described as being a 6 dB gain stacked dipole with -20 dB isolation 90° off boresight. The February 5, 1997 letter refers to a part number for a 10 dB gain antenna with -25 dB isolation off boresight. In our analysis Primosphere assumes the January 30, 1997 description is correct since it has the characteristics used to defend the PACS link analysis.

4.2.2 3 dB of Isolation for Polarization Loss

DigiVox Assumption:	3 dB of isolation
Actual:	1-2 dB of isolation

DigiVox assumes 3 dB of isolation based on the fact that the PACS signal is linearly polarized and the SDARS antenna is circularly polarized. While this is theoretically possible, attainable antenna isolation is actually 1-2 dB when one considers actual axial ratios, particularly at low elevation angles. Primosphere

has used 2 dB in its analysis. As previously noted, it is curious that a mobile, hand held system like PACS, is not designed with a circular antenna polarization. Circular antenna polarization would provide better performance, and if designed to be cross-polarized with SDARS could achieve 10-15 dB of isolation between PACS and SDARS without performance penalty.

Thus, taking the above corrections into account, the DigiVox filing underestimates interference from a PACS base station or fixed antenna into the SDARS band by 9-11 dB.

DigiVox then goes on to calculate margin based on its flawed assumption that a 2 dB increase in SDARS noise floor from a single fixed transmitter is acceptable. The result is an optimistic estimate of SDARS resistance to out-of-band emissions interference coming from PACS units operating in the WCS bands. The result is a DigiVox calculation of 1.9 dB of margin and a corrected calculation of a 21.7 dB deficit. That is a dramatic 23.6 dB difference!

As with the hand set, the assertion by DigiVox that reduced out-of-band emission limits are safe is again totally wrong and should be rejected. Primosphere calculates that a PACS fixed antenna would have to be over 945 feet away from an SDARS receiver to have the margin calculated by DigiVox. This calculation is based on the corrections listed above and a 0.2 dB increase in SDARS receiver noise from a single PACS fixed transmitter.

5. SIGNAL BLOCKAGE AND ERROR MITIGATION

DigiVox argues that PACS out-of-band emissions interference will be insignificant relative to the degradation caused by blockages in the mobile environment. In support of this assertion DigiVox has quoted a reference suggesting that the failure rate of SDARS services due to such effects will be between 45% and 90%.¹² It should be noted that the cited reference is an unapproved draft report, one whose conclusions have been seriously questioned by participants in the study^{13,14}. Also the main thrust of this single test, in one

¹² "Technical Evaluations of Digital Audio Radio Systems Performance, Draft Report", dated January 1997, CEMA DAR Subcommittee.

¹³ Memorandum to Randall Brunts, Chairman, CEMA DAR Subcommittee, from Donald Messer, VOA, dated January 14, 1997.

¹⁴ Letter to Randall Brunts, Chairman, CEMA DAR Subcommittee, from David Layer, Senior Engineer, NAB, dated January 17, 1997.

location, was the evaluation of terrestrial digital FM.

In contrast, Primosphere has based its link design on the results of an extensive and long term series of detailed scientific studies performed under the supervision of NASA/JPL. These studies have generated many published reports on experiments in the satellite-to-mobile-user propagation environment in numerous locations across the United States. Data has consistently shown a high dependence on blockage related to the elevation angle of the satellite. The Primosphere satellites will be positioned so that most of the CONUS will have elevation angles between 35° and 60° to one of the two satellites. At these angles of elevation, blockages that cannot be compensated for by reasonable fade margin will occur between 1% and 15% of the time^{15, 16, 17}. Even though total blockage may be on the order of 15% in certain mobile environments, specific blockage events are generally short in duration and become uncorrelated over time¹⁸. The results show that outage-level fades lasting more than 3 seconds occur only about 2% of the time. Short duration fades can be effectively mitigated by advanced coding and time interleaving techniques.

After acknowledging that PACS interference may, in fact, cause errors in 1/8 of the SDARS data bits, HNS claims that error correction coding can alleviate the impact¹⁹. Primosphere links do contain error correction coding and symbol interleaving, as do most satellite-to-ground links, but with the goal of improving performance under signal fading and blockage conditions as described above. If the existing coding were used to “undo” PACS out-of-band emissions interference, the link would not provide acceptable performance. Adding additional coding to the downlink data stream is not possible due to the limitation of satellite power and the available operating bandwidth of 12.5 MHz.

¹⁵ Vogel and Goldhirsh, “Propagation Effects for Land Mobile Satellite Systems: Overview of Experimental and Modeling Results”, NASA Reference Publication 1274, 1992.

¹⁶ Bell, Gevorgiz, Vaisnys, Julian, “Overview of Techniques for Mitigation of Fading and Shadowing in the Direct Broadcast Satellite Radio Environment”, International Mobile Satellite Conference, June 1995.

¹⁷ Akturan and Vogel, “Photogrammetric Mobil Satellite Service Prediction”, University of Texas EE Research Lab, EERL-94-A15R1, 30 December 1994

¹⁸ Lutz, Cygan, Dippold, Dolainsky, Papke, “The Land Mobile Satellite Communication Channel -- Recording , Statistics, and Channel Model”, IEEE Transactions on Vehicular Technology, Vol. 40, No. 2, May 1991.

¹⁹ February 5, 1997 letter from Stan Key , Assistant VP HNS to John Prawat President and CEO DigiVox

6. CONCLUSION AND RECOMMENDATIONS

The material submitted by DigiVox in support of its Petition for Reconsideration contains no new information. It is simply a rehash of material that has been submitted, considered and rejected by the Commission on several occasions. This material underestimates the need for SDARS protection, recommends guard bands that limit WCS usage without protecting SDARS, is wrong in its analysis of PACS out-of-band emission interference into the SDARS band and incorrectly characterizes the blockage statistics. SDARS would be seriously damaged by acceptance of the out-of-band emissions limits proposed by DigiVox. On the other hand, the impact on PACS of complying with the current WCS out-of-band emissions requirements were generally not addressed by DigiVox, except for the following two statements:

“... the adopted limits will require providers of low-tier PACS services on the WCS spectrum to totally redesign their base stations from the ground up in ways that would increase the costs of providing PACS service on the spectrum to the public.”

“... to meet the technical specifications required by the adopted limits, each ‘handset’ would have to be the size of a briefcase and would be prohibitively expensive.”

In actual fact, after correcting for errors in the HNS analysis, the out-of-band emissions from the PACS system can be easily brought into compliance with the WCS limits recently set by the Commission. This can be achieved through the use of output filters rolling off in the proposed buffer frequency band between the WCS segments targeted for PACS and the SDARS band. Rather than loosening the WCS out-of-band emission limits, the Commission should urge DigiVox to insist on better performance from its PACS equipment suppliers.

DigiVox repeatedly raises the same arguments, supported by the same inaccurate engineering as it has in its past filings in the hope that repeating the material will turn error into truth. The DigiVox estimate of PACS out-of-band emissions interference with SDARS operation was wrong in January, wrong in February and is wrong now again.

The Commission wisely rejected the assertions as to out-of-band emissions limits submitted by DigiVox in preparing the WCS Rule Making and should protect SDARS by affirming its decision and again reject the flawed engineering presented by DigiVox.

TABLE 1 REVERSE DIRECTION INTERFERENCE LINK BUDGET

PARAMETER		CURRENT WCS LIMITS	DIGIVOX CALCULATION	CORRECTED DIGIVOX CALCULATION	COMMENTS
Handset Out-of-Band Emission Standard	(dBW/MHz)	-110.0	-81.0	-81.0	Digivox proposes a 29 dB loosening of current limit
Handset Duty Cycle	dB	0.0	-9.0	0.0	There is no link loss attributable to duty cycling XMTR. SDARS data rate much higher than WCS, and thus must use peak power not average
Distance to SDARS Receive Antenna	(m)	4.0	4.0	4.0	HNS assumed 12' or 4 m separation
Frequency	(MHz)	2320.0	2320.0	2320.0	
Free Space Path Loss	(dB)	-51.8	-51.8	-51.8	
SDARS Antenna Gain	(dB)	3.0	3.0	3.0	Primosphere filings
Head Loss	(dB)	0.0	-5.0	2.0	The human head provides no shielding over full circle. Measured data shows 2-4 dB increase in direction perpendicular to head.
SDARS Beam Shape	(dB)		-6.0		Handset can be directly in SDARS antenna boresight
Polarization Loss	(dB)	-2.0	-3.0	-2.0	Theoretical circular to linear polarization decoupling is 3 db, obtainable is only 1 - 2 dB.
Interference from Single WCS XMTR into SDARS Receiver	(dBW/MHz)	-160.8	-152.8	-129.8	Digivox out-of-band emissions from a single handset is sufficient to break SDARS receive link
SDARS Receiver Noise Floor	(dBW/MHz)	-145.6	-142.6	-145.6	Primosphere receiver noise floor is 3 dB better than Digivox allocation
Allowable Noise Increase from a Single WCS XMTR	(dB)	0.2	2.0	0.2	Acceptable noise floor increase from single XMTR is 0.2 dB
Resultant Allowable Interference	(dBW/MHz)	-158.9	-144.9	-158.9	
Margin	(dB)	1.9	7.9	-29.1	Noise level is 37 dB higher than calculated by Digivox
Distance at which Digivox actual interference equals their calculated value	(m)			281	Corrected interference link budget required spacing to have margin estimated by Digivox

TABLE 2 PROPOSED FORWARD DIRECTION LINK

PARAMETER		CURRENT WCS LIMITS	DIGIVOX CALCULATION	CORRECTED DIGIVOX CALCULATION	COMMENTS
Base Station Out-of-Band Emission Standard	(dBW/MHz)	-90.0	-75.0	-75.0	Digivox proposes a 15 dB loosening of current limit
Distance to SDARS Receive Antenna	(m)	30.0	8.0	8.4	Assumes SDARS antenna is directly under Digivox antenna although this is closest to antenna, it is not worst case
Frequency	(MHz)	2320.0	2320.0	2320.0	
Free Space Path Loss	(dB)	-69.3	-57.8	-58.2	Worst case interference just before and just after passing directly under antenna.
Base Station Antenna Gain at Boresight	(dB)	6.0	6.0	6.0	Peak Digivox antenna gain
Directivity Loss	(dB)	-3.0	-20.0	-11.0	SDARS antenna is at -11 dB down point in Digivox beam
SDARS Antenna Gain	(dB)	3.0	3.0	3.0	Primosphere filings
Polarization Loss	(dB)	-2.0	-3.0	-2.0	Theoretical circular to linear polarization decoupling is 3 dB, obtainable is only 1 to 2 dB
Interference from Single Digivox XMTR into SDARS Receiver	(dBW/MHz)	-155.3	-146.8	-137.2	
SDARS Receiver Noise Floor	(dBW/MHz)	-145.6	-142.6	-145.6	Primosphere receiver noise floor is 3 dB better than Digivox allocation
Allowable Noise Increase from a Single WCS XMTR	(dB)	0.2	2.0	0.2	Acceptable noise floor increase from single Digivox XMTR is 0.2 dB
Resultant Allowable Interference	(dBW/MHz)	-158.9	-144.9	-158.9	
Margin	(dB)	-3.6	1.9	-21.7	Margin is actually 23.6 dB less than calculated by Digivox
Distance at which Digivox actual interference equals their calculated value	(m)			315	Corrected interference link budget required spacing to have margin estimated by Digivox

Engineering Certification

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in these comments, that I am familiar with Part 25 of the Commission's Rules, that I have either prepared or reviewed the engineering information submitted in these comments and that it is complete and accurate to the best of my knowledge.


Richard Cooperman

STATEMENT OF RICHARD S. COOPERMAN, TECHNICAL CONSULTANT TO
PRIMOSPHERE LP


On Friday evening February 28, 1997 at approximately 6:30 pm I was contacted by telephone by Mr. John Prawat of Digivox. Mr. Prawat wished to discuss WCS out-of-band emission limits in the SDARS band. This was my first discussion with regard to WCS or SDARS with Mr. Prawat, anyone else from Digivox, or HNS.

Mr. Prawat noted that the Commission in its WCS Rule Making urged the WCS and SDARS licensees to confer with regard to WCS out-of-band emissions interfering with SDARS operations. Mr. Prawat requested that such a meeting be held immediately. I noted that I was committed on Monday, but would gladly meet with Digivox any time after that to discuss this matter. I suggested that he contact the other SDARS applicants to solicit their attendance. We agreed to talk again over the weekend.

Over the weekend I tried to contact Mr. Prawat several times on his cellular phone and left two voice mail messages at his office. I was unable to reach him and he did not return my calls. I again tried contacting him on Monday morning March 3, 1997. Sometime late in the day Monday or on Tuesday he returned my call. We agreed to meet on Wednesday March 5, 1997 to discuss how we would proceed to discuss and resolve the matter of WCS out-of-band emission interference. I noted that I did not represent all four SDARS applicants and that he should contact the other three applicants directly.

No other SDARS applicant technical representatives were contacted and I was the only one to be asked to attend the meeting. At the meeting, rather than discuss procedures, as previously agreed, Mr. Prawat pushed for acceptance of the Digivox position with regard to out-of-band emissions. He also accused all the SDARS applicants of withholding data on their system designs. I noted that there were literally volumes of technical data available in the Commission record on SDARS and I referred him to the technical system descriptions contained in the SDARS applicant filings in the SDARS proceeding. I also gave him the names and telephone numbers of the technical and regulatory contacts at the other three SDARS applicants. I suggested he get copies of the documents, get up to speed on our system designs and then arrange a meeting of all SDARS applicants. We agreed to meet again in the near future and the meeting then ended.

At no point in the meeting did Mr. Prawat raise the existence of his February 5, 1997 ex parte filing nor its request for additional information. Primosphere only learned of this letter's existence upon receipt of the Petition for Expedited Reconsideration on Thursday March 13, 1997. A copy of the letter was finally obtained on Monday March 17, 1997, over a month after its filing with the Commission.

A handwritten signature in black ink, appearing to read "Richard Cooperman", written over a horizontal line.

Richard Cooperman

3/21/97

Date